drops. The drops from the receding edges of showers and storms are more commonly of larger size than are those of the advancing edge.

A most interesting fact observed is that lightning flashes originate most frequently in that portion of the cloud depositing heaviest rainfall and largest size drops. Here may be the explanation of the absence of lightning flashes in certain showers, as well as the excess of it in others; one may be producing small drops, the other very large ones.

The above results of Mr. Bentley's special study seem to harmonize closely with the Editor's general experience and many special observations that he also has made. Large raindrops seem to require for their formation rapid upward currents; small raindrops and cloud particles are produced in gently rising currents. Fine and gentle rains may fall from the thin horizontal cloud strata that are formed by mixture at the boundary between two currents of different temperatures flowing past each other, but larger drops and heavy rains require a decided cumulus type of cloud and rapidly cooling masses of supersaturated air. Lightning always attends the formation of these large drops of rain or the analogous large snowballs from which hailstones are formed. The hypothesis submitted by the Editor in 1892, and reproduced in Agricultural Science in 1892, Vol. VI, p. 307, from which we make the following extract, still seems to be worthy of experimental investigation.

THE FORMATION OF LARGE RAINDROPS.

In an article on the production of rain, published in Agricultural Science for 1892, Vol. VI, p. 297–309, the present writer reviewed the various hypotheses that have been suggested as to the method of formation of rain, hail, and snow and the possibility of preventing destructive storms. At the close of his article the author said:

As to these various hypotheses that have been suggested concerning the method by which the agglomeration of droplets into large drops is actually effected by nature in her regular process of making rain, I must remark that it is not yet clear to me that any one has demonstrated that small drops actually do agglomerate into larger ones to any considerable extent. I think it quite possible that the union of small cloud particles into larger ones is only effective in driving fogs, or in clouds whose upper surfaces cool by radiation, but is, after all, not an important feature in the natural production of generous rains and summer thundershowers. It is a reasonable working hypothesis that the particles which were originally too small to fall from the clouds with any rapidity actually remain there entangled in the currents of air that characterize clouds, and that they are subsequently evaporated, while, on the other hand, only those fall as rain which, originally, had a size vastly larger than the average size of the smaller particles that constitute the major portion of a cloud. There may be some reason why the condensation of the superabundant molecules of a saturated vapor should form not merely cloud particles whose diameter is ordinarily less than one-hundredth of an inch, but also here and there, large drops which fall to the ground as rain with very much the same size as when originally formed a few moments before in the clouds. The sudden pour of heavy rain from a limited region within a thunder cloud can not be due to a general slow progressive agglomeration of droplets into drops.

On this point I submit the following modification of ideas suggested by reading von Bezold's fourth paper "On the Thermodynamics of the Atmosphere, Berlin, 1892." It suggests a new point of view, and one that demands further experimental elucidation.

Von Bezold suggests that the heavy rains generally known as cloud-bursts are immediately preceded by, and may owe their origin to, a supersaturated state of the atmosphere, by reason of which a greater quantity of vapor is contained in the air than would under other conditions be possible at a given temperature. Following out this hypothesis I conclude that whatever molecular condition it be that permits the existence of a supersaturated atmosphere, it is evident that the removal, or annulment, of that condition must give rise to an immediate and heavy condensation. This principle may be extended to all ordinary rains as well as to the violent thundershowers and cloud-bursts.

The supersaturated condition must be considered as a case of adiabatic expansion,[1] accompanied by a delay in the occurrence of the appropriate condensation; so far as we at present know, this condition can occur only in those cases where all foreign substances, or dust particles, are absent, which might serve as nuclei for the formation of fog particles. A slowly rising and cooling atmosphere first condenses its moisture on the dust nuclei and forms minute droplets; these grow very slowly, by diffusion, up to a definite size proper to the prevailing temperature and vapor tension, but the intermediate air, in which these droplets are floating, keeps on cooling as a dust-free supersaturated vapor. If the sun shines on these droplets its heat powerfully contributes to evaporate them and further saturate the surrounding air.

In general, therefore, the ascending portions of every cloud contain supersaturated, dust-free vapor separating the isolated droplets. When by further expansion and cooling the supersaturation has proceeded to such an extent that further condensation must occur, this latter molecular change permeates the supersaturated space with a rapidity comparable to that with which any other chemical change takes place, just as when the explosive union of chlorine and hydrogen, or of oxygen and hydrogen, starting at any one point, almost instantaneously permeates a mass of those mixed gases, or, as when combustion runs along a train of gunpowder. The vapor molecules from the supersaturated spaces are quickly brought together by their molecular attractions into heavy drops of warm water, which are often distinct from the intermediate cooler droplets, and descend rapidly from the clouds, while the latent heat of condensation is communicated to the adjoining air and is left behind in the cloud. Thus simultaneously with the formation and fall of the big drops there is a sudden expansion of that portion of the clouds from which they came. Von Bezold thinks that such expansion may possibly be felt at the earth's surface as a sudden rise in the barometer, while it is also visible to the eye as a sudden expansion of the cloud into the so-called thunder head. I myself doubt whether there would be any appreciable barometric result, yet I consider that the sudden expansion and ascent of the white cloud and its subsequent rapid dissipation into the surrounding air, together with the simultaneous lightning, thunder, rain, hail, and ascending whirl of wind, all conspire to make it very plausible that there really existed a supersaturated condition at the moment immediately preceding.

If the temperature of the dew-point of the ascending air, or the temperature of supersaturation is below freezing, the condensation of the vapor may at once form, not drops, but large snowflakes, such as will fall rapidly to the ground, or the small hail that is ordinarily called sleet.

Correlated phenomena occur when a cloud consists of small particles of water cooled below the freezing point, as is known to be frequently the case. When for any reason these particles are suddenly converted into ice, as will happen when they are cooled low enough or when they jostle against each other, their temperatures at once rise to the freezing point, a large quantity of heat is set free, the cloud expands and rises, and the droplets of water are converted into spiculæ of ice, or small snowflakes; large flakes and hailstones are not to be explained in this manner.

There is some plausibility in the hypothesis that the critical electrical condition, which results in lightning, is directly due to the disruption of the condition of extreme supersaturation and the sudden formation of large drops of water, or to the disruption of the condition of water cooled below the freezing point, and the consequent sudden formation of ice or snow, but this remains to be investigated.

Therefore, according to this latest view of the subject, the problem of the artificial formation of rain will be partially solved and, sufficiently so for practical purposes, if some method is invented by which to bring about a sudden formation of a small percentage of large drops out of the moist air that exists between the small particles of every cloud.

At present our attention and experiments should be directed toward understanding and completing the natural and obscure process involved in the formation of rain within the cloud and not toward the forcing of any unnatural process.

[1] Without adding or subtracting heat.

PHOTOGRAPHY IN METEOROLOGY.

The art of photography has proved such an exceedingly useful method of studying and exhibiting meteorological phenomena that it behooves us to stimulate its development and application in every practicable way. Photographs of clouds for the purpose of securing types of the different classifications began to be made as early as photography technically so-called was invented, say, about 1845 (?), and immediately replaced the less satisfactory daguerreotype method of 1839. The use of colored screens, absorbing cells, and polarizing plates which cut off the diffuse light and blue light of the sky, has contributed to the perfection of cloud photographs.

The application of photography to determine the heights and movements of clouds has only been satisfactorily developed within the past ten years, although it was undoubtedly suggested and tried as early as 1857. The study of lightning, by means of photography began, we believe, with the work of Dr. H. Kayser, of Berlin, in 1884, and von Hænsel in 1883.

In studying the distribution of polarized light over the sky it may be practicable to so arrange the apparatus that the relative amount of polarization may be deduced by photographed records, so as to give a general view of the condition of a large portion of the sky. The record of the amount of sunshine and cloudiness by the so-called Jordan sunshine recorder is well known, although this is strictly speaking a blue print rather than a photographic process. A photograph of the distorted disc of the sun near the horizon, if one could be taken, would be a record of the irregularities of atmospheric refraction, and, therefore, of the density of superposed layers of air.

Photographs of snow crystals, frost work, sections of hailstones, views of waterspouts and tornadoes, halos, rainbows, and glories are not rare. Even the waves of compression in the atmosphere attending a bullet or an explosion, or any wave of sound, as also the streams of mixed warm and cold air flowing around an obstacle have been photographed.

Those meteorologists who take a personal interest in all these applications of photography will appreciate the efforts that are being made by the Royal Photographic Society of London to extend the scope of its annual exhibitions to every branch of photography and its applications. Those who have interesting photographs or photographic apparatus that they wish to exhibit should communicate directly with Mr. John A. Hodges, Honorary Secretary, No. 66 Russell Square, London, W. C. The exhibition will be opened on October 1 and medals will be awarded.

The exhibition will be arranged in five sections, of which the last is entitled Scientific Photography and Photography in its Technical Applications. Under this head, the circular reads as follows:

This section will comprise examples of work shown for its technical qualities and apparatus used in photographic investigations: The various processes of color photography; the photographic reproduction of paintings, drawings, maps; photographs by artificial light; photography applied to industrial and educational purposes, astronomy, spectroscopy, geology, meteorology, microscopy, medicine, surgery, and the Röntgen rays; surveying and engineering; zoology and botany; telephotography, new processes, enlargements; photography applied to military purposes, recording instruments, etc.; negatives, transparencies, stereoscopic prints and slides; lantern slides, and general work.

Exhibits may be excluded unless the points of special technical or scientific interest are distinctly stated.

Medals will be placed at the disposal of the judges, but noncompetitive work will be admitted.

There seems to be a small charge to each exhibitor for the wall space occupied by him.

A NEW METEOROLOGICAL JOURNAL.

By a letter from Mr. A. J. Monné, of Nykerk, we learn that with the cooperation of Mr. Chr. A. C. Nell he proposes to publish a journal for meteorology in the Dutch language. The meteorology of the ocean has, as is well known, been diligently studied by the Dutch navigators, and forms the principal part of the work of the meteorological institute of the Netherlands, founded by Buys-Ballot, and now conducted by Prof. Dr. M. Snellen of the University of Utrecht. Moreover, the islands of the Dutch West Indies and East Indies are so near to the West Indies and Philippines, respectively, that our interest in their meteorology has lately become greatly quickened. We doubt not that the Dutch journal will have much interest for many American readers.

CLIMATIC DIVISIONS OF MISSOURI.

In the annual summary of the Missouri section, for 1899, Mr. A. E. Hackett, Section Director, adds a general review of the climate of Missouri. He divides the State into five physiographic divisions, and attributes to each of them the following normal temperatures and rainfall for the respective seasons:

Divisions.	Normal mean temperatures.				Normal average precipitation.			
	Spring.	Summer.	Autumn.	Winter.	Spring.	Summer.	Autumn.	Winter.
	°	°	°	°	Ins.	Ins.	Ins.	Ins.
Northwest plateau	51.8	74.5	53.6	27.7	10.74	13.62	7.32	4.65
Northeast plain	53.5	75.3	55.1	30.6	11.58	11.87	8.45	6.51
Southwest lowlands	54.3	75.7	56.1	31.9	12.44	12.59	7.79	6.42
Ozark plateau	55.1	74.8	56.2	34.7	14.00	12.75	8.89	8.09
Southeast lowlands	58.0	76.7	58.3	37.3	14.52	11.86	9.90	10.57
State	54.5	75.3	55.9	32.4	12.65	12.44	8.47	7.25

THE EFFECTS OF DIMINISHED PRESSURE ON COOKING.

In the January report of the New Mexico section Mr. R. M. Hardinge quotes the following from a cook book issued by the ladies' guild at Albuquerque, N. Mex. The whole article seems to give results of actual experience and careful observation on a subject which is now attracting great attention at the hands of experimental stations that are doing for the kitchen that which has already been done for the farms and the workshops. Some of the hypothetical explanations given by Mrs. C. L. Herrick, to whom this article is due, may not stand the test of further scientific investigation, but the whole subject is eminently worthy the attention of the chemists.

It is a matter of common observation among housekeepers in New Mexico that recipes and practices found reliable elsewhere fail to achieve the expected results on the Plateau.

Some of us have endured many trying experiences in adapting our cooking to our environment, and it is to aid friends to a more easy accomplishment of these household tasks that these lines are written.

One of the difficulties has been with our cake mixing and baking. It took me a long time to discover that the use of the same number of eggs I had been accustomed to in a lower altitude caused my cakes to be a failure. I now use half as many as my eastern recipes call for, adding two tablespoons of milk or water for each egg left out. The reason for this is that the albumen of the egg, when added to the batter, forms a tenacious coating, which helps it to retain the gases that tend to escape by virtue of their expansion. The albumen is much heavier than the gases engendered by the raising agent, and when the atmospheric pressure is heavier, as in lower altitudes, it is impossible for these gases to escape so rapidly, and there is time for the batter to be thoroughly aerated before hardening.

Here the heat of our ovens is longer in penetrating, the atmospheric pressure is diminished, and the gases tend to escape before the heat is sufficient to harden. This escape of the gases prevents the aeration of so large a quantity of the albumen, and the superfluous amount serves but to toughen the cake. It is necessary to apply the heat quickly and evenly in order to coagulate the albumen and prevent the collapse or "falling" of the cake.

Less shortening and less sugar can be used here, because of their weight and, also, because both melt in the process of baking, and in this way dilute the batter and make it easier for the gases to escape. To counteract this, more flour must be used, the proteids of which form a glutinous consistency which prevents the escape of the gases.

It has been found more satisfactory to add the raising agent after all other mixing is done and just as the batter is ready to place in pans for the oven. This prevents the escape of the gases before reaching the oven, which is sure to occur if the raising agent is sifted through the flour and added gradually, as we were accustomed to mix ingredients in a lower altitude, for effervescence begins as soon as the raising agent is moistened.

I have been much more successful in using one teaspoonful of soda with two teaspoons of cream of tartar as a raising agent when a teaspoon of baking powder is called for, without, however, being able to determine the reason.

We are all familiar with the varying temperature of boiling water